CLAIMS

What is claimed is:

1. A method for synthesizing an auditory scene, comprising:

processing at least one input channel to generate two or more processed input signals;

filtering the at least one input channel to generate two or more diffuse signals; and

combining the two or more diffuse signals with the two or more processed input signals to generate a plurality of output channels for the auditory scene.

2. The invention of claim 1, wherein processing the at least one input channel comprises:

converting the at least one input channel from a time domain into a frequency domain to generate a plurality of frequency-domain (FD) input signals;

delaying the FD input signals to generate a plurality of delayed FD signals; and

scaling the delayed FD signals to generate a plurality of scaled, delayed FD signals.

3. The invention of claim 2, wherein:

the FD input signals are delayed based on inter-channel time difference (ICTD) data; and

the delayed FD signals are scaled based on inter-channel level difference (ICLD) and inter-channel correlation (ICC) data.

4. The invention of claim 3, wherein:

the at least one input channel is at least one combined channel generated by performing binaural cue coding (BCC) on an original auditory scene; and

the ICTD, ICLD, and ICC data are cue codes derived during the BCC coding of the original auditory scene.

5. The invention of claim 4, wherein the at least one combined channel and the cue codes are transmitted from an audio encoder that performs the BCC coding of the original auditory scene.

6. The invention of claim 3, wherein different ICTD, ICLD, and ICC data are applied to different frequency sub-bands of the corresponding FD signals.

7. The invention of claim 2, wherein:

the diffuse signals are FD signals; and

the combining comprises, for each output channel:

summing one of the scaled, delayed FD signals and a corresponding one of the FD diffuse input signals to generate an FD output signal; and

converting the FD output signal from the frequency domain into the time domain to generate the output channel.

8. The invention of claim 7, wherein filtering the at least one input channel comprises:

applying two or more late reverberation filters to the at least one input channel to generate a plurality of diffuse channels;

converting the diffuse channels from the time domain into the frequency domain to generate a plurality of FD diffuse signals; and

scaling the FD diffuse signals to generate a plurality of scaled FD diffuse signals, wherein the scaled FD diffuse signals are combined with the scaled, delayed FD input signals to generate the FD output signals.

9. The invention of claim 8, wherein:

the FD diffuse signals are scaled based on ICLD and ICC data;

the at least one input channel is at least one combined channel generated by performing BCC coding on an original auditory scene; and

the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

10. The invention of claim 9, wherein the at least one combined channel and the cue codes are transmitted from an audio encoder that performs the BCC coding of the original auditory scene.

11. The invention of claim 9, wherein different ICLD and ICC data are applied to different frequency sub-bands of the corresponding FD signals.

12. The invention of claim 7, wherein filtering the at least one input channel comprises:

applying two or more FD late reverberation filters to the FD input signals to generate a plurality of diffuse FD signals; and

scaling the diffuse FD signals to generate a plurality of scaled diffuse FD signals, wherein the scaled diffuse FD signals are combined with the scaled, delayed FD input signals to generate the FD output signals.

13. The invention of claim 12, wherein:

the diffuse FD signals are scaled based on ICLD and ICC data;

the at least one input channel is at least one combined channel generated by performing BCC coding on an original auditory scene; and

the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

14. The invention of claim 13, wherein different ICLD and ICC data are applied to different frequency sub-bands of the corresponding FD signals.

15. The invention of claim 1, wherein the method generates more than two output channels from the at least one input channel

16. The invention of claim 15, wherein the method synthesizes a surround sound auditory scene.

17. The invention of claim 15, wherein a single input channel is used to synthesize the auditory scene.

18. The invention of claim 1, wherein:

the method applies the processing, filtering, and combining for input channel frequencies less than a specified threshold frequency; and

the method further applies alternative auditory scene synthesis processing for input channel frequencies greater than the specified threshold frequency.

19. The invention of claim 18, wherein the alternative auditory scene synthesis processing involves coherence-based BCC coding without the filtering that is applied to the input channel frequencies less than the specified threshold frequency.

20. Apparatus for synthesizing an auditory scene, comprising:

means for processing at least one input channel to generate two or more processed input signals;

means for filtering the at least one input channel to generate two or more diffuse signals; and

means for combining the two or more diffuse signals with the two or more processed input signals to generate a plurality of output channels for the auditory scene.

21. Apparatus for synthesizing an auditory scene, comprising:

a configuration of at least one time domain to frequency domain (TD-FD) converter and a plurality of filters, the configuration adapted to generate two or more processed FD input signals and two or more diffuse FD signals from at least one TD input channel;

two or more combiners adapted to combine the two or more diffuse FD signals with the two or more processed FD input signals to generate a plurality of synthesized FD signals; and

two or more frequency domain to time domain (FD-TD) converters adapted to convert the synthesized FD signals into a plurality of TD output channels for the auditory scene.

22. The invention of claim 21, wherein the configuration comprises:

a first TD-FD converter adapted to convert the at least one TD input channel into a plurality of FD input signals;

a plurality of delay nodes adapted to delay the FD input signals to generate a plurality of delayed FD signals; and

a plurality of multipliers adapted to scale the delayed FD signals to generate a plurality of scaled, delayed FD signals.

23. The invention of claim 22, wherein:

the delay nodes are adapted to delay the FD input signals based on inter-channel time difference (ICTD) data; and

the multipliers are adapted to scale the delayed FD signals based on inter-channel level difference (ICLD) and inter-channel correlation (ICC) data.

24. The invention of claim 23, wherein:

the at least one input channel is at least one combined channel generated by performing binaural cue coding (BCC) on an original auditory scene; and

the ICTD, ICLD, and ICC data are cue codes derived during the BCC coding of the original auditory scene.

25. The invention of claim 23, wherein the configuration is adapted to apply different ICTD, ICLD, and ICC data to different frequency sub-bands of the corresponding FD signals.

26. The invention of claim 22, wherein the combiners are adapted to sum, for each output channel, one of the scaled, delayed FD signals and a corresponding one of the diffuse FD signals to generate one of the synthesized FD signals.

27. The invention of claim 26, wherein

each filter is a TD late reverberation filter adapted to generate a different TD diffuse channel from the at least one TD input channel;

the configuration comprises, for each output channel in the auditory scene:

another TD-FD converter adapted to convert a corresponding TD diffuse channel into an FD diffuse signal; and

an other multiplier adapted to scale the FD diffuse signal to generate a scaled FD diffuse signal, wherein a corresponding combiner is adapted to combine the scaled FD diffuse signal with a corresponding one of the scaled, delayed FD signals to generate one of the synthesized FD signals.

28. The invention of claim 27, wherein:

each other multiplier is adapted to scale the FD diffuse signal based on ICLD and ICC data;

the at least one input channel is at least one combined channel generated by performing BCC coding on an original auditory scene; and

the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

29. The invention of claim 28, wherein the configuration applies different ICLD and ICC data to different frequency sub-bands of the corresponding FD signals.

30. The invention of claim 26, wherein:

each filter is an FD late reverberation filter adapted to generate a different FD diffuse signal from one of the FD input signals; and

the configuration further comprises a further plurality of multipliers adapted to scale the FD diffuse signals to generate a plurality of scaled FD diffuse signals, wherein the combiners are adapted to combine the scaled FD diffuse signals with the scaled, delayed FD signals to generate the synthesized FD signals.

31. The invention of claim 30, wherein at least two FD late reverberation filters have different filter lengths.

32. The invention of claim 30, wherein:

the FD diffuse signals are scaled based on ICLD and ICC data;

the at least one input channel is at least one combined channel generated by performing BCC coding on an original auditory scene; and

the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

33. The invention of claim 32, wherein the configuration applies different ICLD and ICC data to different frequency sub-bands of the corresponding FD signals.

34. The invention of claim 21, wherein the apparatus is adapted to generate more than two output channels from the at least one TD input channel.

35. The invention of claim 34, wherein the apparatus is adapted to synthesize a surround sound auditory scene.

36. The invention of claim 34, wherein the apparatus is adapted to use a single input channel to synthesize the auditory scene.

37. The invention of claim 21, wherein the apparatus comprises one filter for every output channel in the auditory scene.

38. The invention of claim 21, wherein each filter has a substantially random frequency response with a substantially flat spectral envelope.

39. The invention of claim 21, wherein:

the apparatus is adapted to generate, combine, and convert for TD input channel frequencies less than a specified threshold frequency; and

the apparatus is further adapted to apply alternative auditory scene synthesis processing for TD input channel frequencies greater than the specified threshold frequency.

40. The invention of claim 39, wherein the alternative auditory scene synthesis processing involves coherence-based BCC coding without the filters that are applied to the TD input channel frequencies less than the specified threshold frequency.